

What is claimed is:

1. A sputtering apparatus for use in an evacuated volume comprising:

ion source means for ionizing an ionizable gas to produce a plasma, wherein ions leaving said ion source means are in the  
5 form of an ion efflux having an energy of about 50 eV or less;

a sputter target, biased negative relative to ground, and having a curved target surface, wherein said curved target surface is disposed in the ion efflux of said ion source means, whereby particles of material are sputtered from said target;

10 a deposition substrate upon which the material sputtered from said sputter target is deposited;

and wherein said ionizable gas within said evacuated volume is at a first pressure and said ionizable gas within said ion source is at a second pressure, and wherein said first  
15 pressure is substantially less than said second pressure.

2. A sputtering apparatus in accordance with claim 1, wherein said curved target surface is concave.

3. A sputtering apparatus in accordance with claim 1, wherein said curved target surface is convex.

4. A sputtering apparatus in accordance with claim 1, further comprising a magnetic field located near said sputter target and having sufficient strength and thickness to contain secondary electrons generated by said ion efflux striking said  
5 sputter target.

5. A sputtering apparatus for use in an evacuated volume comprising:

ion source means for ionizing an ionizable gas to produce  
a plasma, wherein ions leaving said ion source means are in the  
5 form of an ion efflux having an energy of about 50 eV or less;

a sputter target, biased negative relative to ground, with  
said target disposed in the ion efflux of said ion source  
means, whereby particles of the material are sputtered from  
said sputter target;

10 a deposition substrate upon which the material sputtered  
from said sputter target is deposited;

a magnetic field located near said sputter target of  
sufficient strength and thickness to contain secondary  
electrons generated by said ion efflux striking said sputter  
15 target.

and wherein said ionizable gas within said evacuated  
volume is at a first pressure and said ionizable gas within  
said ion source means is at a second pressure, and wherein said  
first pressure is substantially less than said second pressure.

6. A sputtering apparatus as defined in claims 1, 4, or  
5 in which said sputter target is biased by means of a  
radiofrequency bias and in which the negative bias is a mean  
value of the radiofrequency bias.

7. A sputtering apparatus as defined in claims 1, 4, or  
5 in which the bias of said sputter target is a pulsed bias and  
in which the negative bias is a mean value of the pulsed bias.

8. A sputtering apparatus as defined in claims 1, 4, or  
5 in which said sputter target is enclosed by a target

enclosure, where said target enclosure defines the perimeter of the area of said sputter target that is exposed for sputtering.

9. A sputtering apparatus as defined in claims 1, 4, or 5 in which an additional reactive gas is introduced into said evacuated volume to promote the formation of compounds incorporating both said reactive gas and said material 5 sputtered from said sputter target.

10. A sputtering apparatus as defined in claims 1, 4, or 5 in which said ion source comprises a gridless ion source.

11. A sputtering apparatus in accordance with claim 10, wherein said gridless ion source includes an electron-emitting cathode which is biased negative of ground to reduce the energy of the ions in said efflux.

12. A sputtering apparatus as defined in claims 1, 4, or 5 in which said ion source means comprises a hollow cathode.

13. A sputtering apparatus as defined in claims 1, 4, or 5 in which the operation of said ion source means includes pulsed operation.

14. A method for sputtering material from a sputter target onto a deposition substrate in an evacuated volume, the method comprising the steps of:

- (a) providing an ion source means for ionizing an ionizable gas to produce a plasma, wherein ions leaving said ion source means are in the form of an ion efflux having an energy of about 50 eV or less;
- (b) providing a sputter target;

10 (c) biasing said sputter target negative relative to  
ground and disposing said sputter target in the ion  
efflux of said ion source means, whereby material is  
sputtered from said sputter target and whereby  
secondary electrons generated from collision of said  
ion efflux with said sputter target are accelerated  
15 away from said biased sputter target to form a beam  
of electrons;

(d) positioning a deposition substrate in operative  
relation to said sputter target and said beam of  
electrons, whereby said material sputtered from said  
20 sputter target is deposited onto said substrate and  
said beam of electrons strikes said substrate; and

(e) controlling the pressure of said gas within said  
volume such that said pressure is substantially less  
than the pressure of said gas within said ion source  
25 means.

15. A method for sputtering material from a sputter  
target onto a deposition substrate in an evacuated volume, the  
method comprising the steps of:

(a) providing an ion source means for ionizing an  
5 ionizable gas to produce a plasma, wherein ions  
leaving said ion source means are in the form of an  
ion efflux having an energy of about 50 eV or less;  
(b) providing a sputter target;  
(c) biasing said sputter target negative relative to  
10 ground and disposing said sputter target in the ion

efflux of said ion source means, whereby material is sputtered from said sputter target and whereby secondary electrons generated from collision of said ion efflux with said sputter target are accelerated away from said biased sputter target to form a beam of electrons;

(d) positioning a deposition substrate in operative relation to said sputter target, outside of said beam of electrons, whereby said material sputtered from said sputter target is deposited onto said substrate; and

(e) controlling the pressure of said gas within said volume such that said pressure is substantially less than the pressure of said gas within said ion source means.

16. A method for sputtering material from a sputter target onto a deposition substrate in an evacuated volume, the method comprising the steps of:

(a) providing an ion source means for ionizing an ionizable gas to produce a plasma, wherein ions leaving said ion source means are in the form of an ion efflux having an energy of about 50 eV or less;

(b) providing a sputter target;

(c) biasing said sputter target negative relative to ground and disposing said sputter target in the ion efflux of said ion source means, whereby material is sputtered from said sputter target and whereby

secondary electrons generated from collision of said ion efflux with said sputter target are accelerated away from said biased sputter target to form a beam of electrons;

(d) adjusting the magnitude of said ion efflux from said ion source means and the magnitude of said bias of said sputter target to assure unstable operation of said electron beam; and

(e) controlling the pressure of said gas within said volume such that said pressure is substantially less than the pressure of said gas within said ion source means.

17. A method for sputtering material from a sputter target onto a deposition substrate in an evacuated volume, the method comprising the steps of:

(a) providing an ion source means for ionizing an ionizable gas to produce a plasma, wherein ions leaving said ion source means are in the form of an ion efflux having an energy of about 50 eV or less;

(b) providing a sputter target;

(c) biasing said sputter target negative relative to ground and disposing said sputter target in the ion efflux of said ion source means, whereby material is sputtered from said sputter target and secondary electrons are generated by said ion efflux striking said sputter target;

- 15 (d) providing a magnetic field region near said sputter  
target for containing said secondary electrons;
- (e) positioning a deposition substrate in operative  
relation to said sputter target whereby said  
material sputtered from said sputter target is  
20 deposited onto said substrate; and
- (f) controlling the pressure of said gas within said  
volume such that said pressure is substantially less  
than the pressure of said gas within said ion source  
means.
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